CS585 Example Project Proposal

Diane H. Theriault

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Note: For your project, you only need to propose 3 ideas

There are four ideas contained in this sample. Your proposal should contain three ideas. You may use the ideas from the sample, but you should develop your own analysis of the subtasks and potential difficulties. If anyone would like to work on segmenting fish or wing damage, that would be directly helpful to ongoing research in our group and I will provide data.

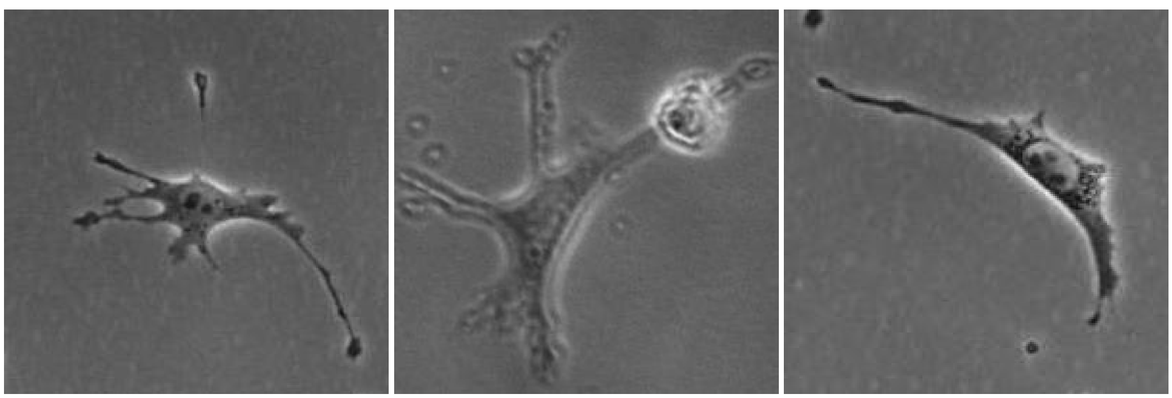
The ideas in your proposal are non-binding. When you begin to do the technical work for your project, you may use an idea from your own proposal, an idea from someone else's proposal, an idea from this sample, or an entirely new idea.

1 Tracking Cell Position and Changes in Shape

Biologists who study cells are interested in understanding how those cells move, change their shape, and proliferate under various environmental conditions. I am interested in tracking and characterizing the shape of cells in time-lapse phase-contrast microscopy images. I have several datasets of time-lapse microscopy images available to me, which have been collected by our collaborators in our research group. These datasets have been annotated by experts with the location of the cell nucleus and a categorical label for the cell shape.

In order to perform this task, I will need to be able to locate and identify the boundaries of the cells in the images, and then determine the correspondence between cells detected in consecutive frames in order to track the cells. I will also need to find some way to represent and classify the shape of the cells. If these tasks are done successfully, I will be able to use my automated system to produce cell location and shape annotations similar to those provided by the experts.

Identifying the unique location of the cells is difficult because the expert intuitively understands the cell location as the nucleus of the cell, but the nucleus is hard to differentiate from the rest of the cell and it is not always visible when the images are blurry. Characterizing the shape of the cells is difficult because categorical labels are not a natural way to represent cell shape, which changes continuously. It may be challenging to develop measurements of cell shape that are biologically interprettable. Finally, the cells often touch each other, and so it can be hard to separate the individual cells.

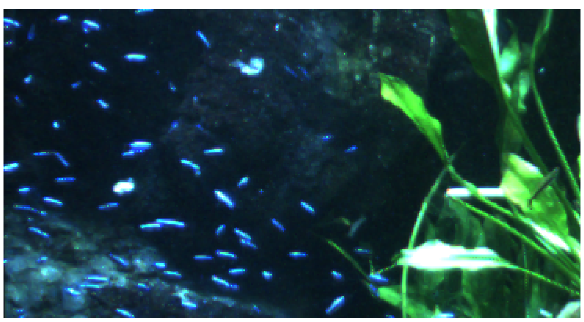
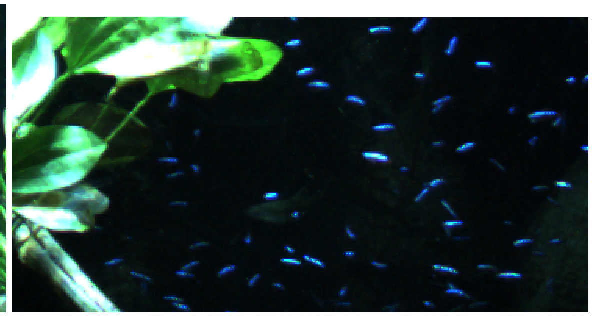


2 Tracking Fish in 3D

The collective motion of animals has been studied computationally since the early 1980's. I would like to obtain the swimming trajectories of fish in order to evaluate the ability of models of collective motion to predict their behavior. We have an hour of video of cardinal tetras swimming in the Anaconda tank at the New England Aquarium, collected with three synchronized cameras. Some swimming trajectories of some fish have been annotated in all three camera views by another student.

In order to obtain the swimming trajectories, I will need to be able to detect the fish in each camera view, then identify the same fish in each view for all three cameras and find the correspondence between the reconstructed positions in each frame in order to track the fish. If these tasks are done successfully, I will be able to identify the positions of the fish at each moment in time. Since the true position of the fish is not known, I will need to rely on some metrics that I can compute about the quality of the correspondences, and the smoothness of the tracks in order to assess whether my detection and correspondence has been done well.

I would like to focus on the task of identifying the individual fish in the video. Even though the fish are bright blue, they are difficult to identify because there are other objects in the tank with a similar color. Also, since there are many fish present, the fish often occlude each other so that the images of different fish touch and it is difficult to separate the individual fish. The only significant, visible marking on the fish is a bright blue stripe, and so it is difficult to find a unique point on the fish that we will be able to use to uniquely identify the correspondence between the images of the fish in the three camera views.

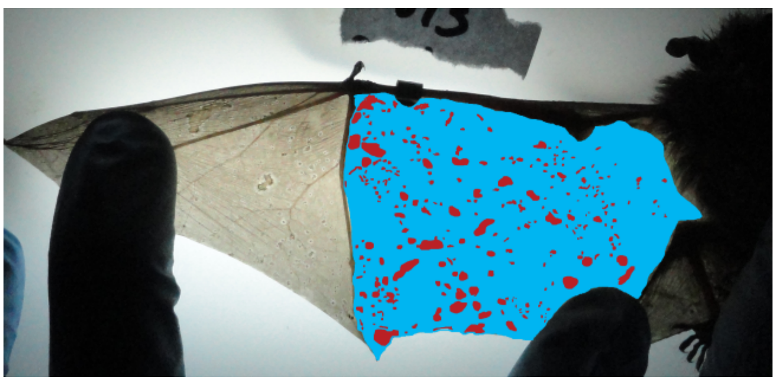



3 Assessing Wing Damage

White nose syndrome is a fungal infection that affects bats during and as they emerge from hibernation. It has devastated bat populations in the Northeast, is moving west-ward across the United States, and may cause the extinction of the Little Brown bat (*Myotis lucifugus*) within the next decade. Scientists are trying hard to understand the disease in order to find ways to help protect bat species. I am interested in automatically identifying regions of bat wings that have been damaged by the fungus, in order to quantify both the damage caused by the disease and subsequent healing. My collaborator has provided a dataset of images of bat wings and associated annotations.

In order to perform this task, I will need to be able to find the bat wing in the image, then use some segmentation algorithm to identify the healthy and diseased tissue. Since the images are very complex, I may need to design a semi-automated system that will require some user input. If these tasks are done successfully, I will be able to identify regions of damage in the images of the wings in a way that matches the annotations provided by the Biologist, and I will also allow the Biologist to annotate the wings more quickly than if they were performing the annotation unassisted.

This task is challenging because the regions of damage and healthy tissue are visually similar and there are many regions of damage scattered throughout the wing. Designing a semi-automated system may challenging because designing an input interface for non-computer scientists can involve handling many unforseen boundary cases.



4 Creating an Image Mosaic

I am interested in making image mosaics by combining several overlapping images of a scene in order to form one larger, composite image. I plan to collect data using the camera in my phone to take pictures and video of scenes that I find interesting.

In order to make an image mosaic, I will need to be able to determine the spatial relationships between input images and then combine the images in some way. If these tasks are done successfully, I will be able to create a large, composite image that faithfully represents the larger scene without duplicating or missing image information. The composite image should be free of discontinuities from image boundaries.

Computing the spatial relationships between images may be challenging because I will need to choose an appropriate geometrical model to represent the spatial relationships, and I will also need to develop a way to find feature points to use in order to compute the parameters of the model. Combining the images may be challenging because different images may have different brightness settings, or the geometric model I choose to represent the relationship between images may not completely match the relationship between images that results from real camera motion and optics.